CHALMERS

A teaching incentive

The Manila amendment and the learning outcome in tanker education

Master of Science Thesis in Nordic Master in Maritime Management

OLLE LINDMARK

Department of Marine and Shipping Technology
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden, 2012
Report No. NM-12/23

REPORT NO. NM-12/23

A teaching incentive

The Manila amendment and the learning outcome in tanker education

Olle Lindmark

Department of Shipping and Marine Technology

CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden, [2012]

A teaching incentive

The Manila amendment and the learning outcome in tanker education

OLLE LINDMARK
olle.lindmark@chalmers.se

Report no NM-12/23
Department of Marine and Shipping Technology
Chalmers University of Technology
SE-41296 Gothenburg
Sweden
Telephone +46 (0)31-772 1000

Cover: The cargo handling simulator, Lindholmen Photo: Jan-Olof Yxell Goteborg, Sweden, 2012

Printed by Chalmers
Gothenburg, Sweden 2012

A teaching incentive
The Manila amendment and the learning outcome in tanker education

OLLE LINDMARK
Department of Marine and Shipping Technology
Chalmers University of Technology

ABSTRACT

The change in maritime legislative demands, both national and international, has had a significant impact on the training and education within the maritime domain. The STCW Convention is the statutory text that regulates the training, certification and watchkeeping for seafarers. During the last few years, the STCW Convention has been revised to include updated group of tasks, duties and responsibilities as well as specification on the type and extent of training and education and subsequently on the training equipment used. This update is called the Manila amendment and has entered into force as of January 2012.

Some parts of the maritime sector can be considered as high-risk areas and the transportation of petroleum and chemicals in bulk can be one of them due to the impact on health and environment those substances have unless handled properly. Specific demands on personnel competencies will call for a need for specific training and education as well as specific types of training equipment.

Quality efforts in education and training should include parts of assessment and evaluation to monitor how well the training objectives have been met. The Manila amendment opens up for an extended use of simulators for the assessment of competency. A simulator can be a powerful tool in the learning process, but it is still very important to measure the effect that the tool has in reaching the goals outlined in the curriculum.

This Master's Thesis will show the impact of changed legislative demands in tanker education and how a cargo-handling simulator can be used to enhance student learning. It will also look into how a cargo simulator will perform in the ability to measure students' competence in tanker handling in the light of the goals stipulated in the STCW Code.

Key words: MET, STCW Convention, The Manila amendment, Cargo handling simulator, assessment of competency, pedagogy

“Homines dum docent discunt”

“*People learn while they teach”*

Lucius Annaeus Seneca

ACKNOWLEDGMENTS

This master's thesis was carried out during the spring of 2012 as a part of the Nordic Master in Maritime Management programme (NOMAR) at the Chalmers University of Technology. The author participated in NOMAR as a part of his trainee programme at the Department of Shipping and Marine Technology.

First and foremost, I would like to thanks the students who participated in the tanker handling course at Chalmers during the spring of 2012. Without their participation and consent this thesis would not have been possible. A special thanks to all the interviewees who gladly shared their opinions and insights.

Furthermore, I would like to thank my supervisor Elisabeth Saalman at Engineering Education Research, Chalmers University of technology, who has supported me and contributed with valuable comments, suggestions and critically examined my work. With great enthusiasm Elisabeth also provided me with a lot of help as she conducted the interviews that formed one part of this thesis.

Finally, I would like to thank my colleagues at Shipping and Marine Technology who have helped me with finding articles, lending me books, and offered comments and discussion and lightened up my days with many important coffee breaks. I would also like to thank my family and friends for their understanding and support.

Olle Lindmark

Gothenburg, May 2012

TABLE OF CONTENTS

ABBREVIATIONS, ACRONYMS AND TERMINOLOGY

This thesis uses terminology from various fields. A list of terminology has therefore been included in order to make it easier for the reader. First listed are the abbreviations and acronyms used in the thesis, followed by concepts and terms from maritime legislation and education.

ABBREVIATIONS AND ACRONYMS

AR	Action Research
ARPA	Automatic Radar Plotting Aid
CHS	Cargo Handling Simulator
COW	Crude Oil Wash
DNV	Det Norske Veritas – Classification Society
IMO	International Maritime Organization
ISGOTT	International Safety Guide for Oil Tankers and Terminals
MET	Maritime Education and Training
STCW	Standards of Training, Certification and Watchkeeping for seafarers

TERMINOLOGY

Administration	means the Government of the Party. (Party means a State for which the Convention has entered into force.)
Debriefing	In the context of this Master's thesis, debriefing should be considered as part of a learning methodology. The debriefing is a semi-structured process by which the facilitator, once a certain activity is accomplished, makes a series of questions. In this session, the participants reflect over what happened, which gives important insights. The aim with the debriefing is linking the challenge with the actions and the future.
Dilution method	The dilution method assumes that the incoming gas mixes with the original gases in the tank to form a homogeneous mixture throughout the tank. This results in that the concentration of the original gas decreases exponentially.
Enter into force	A treaty comes or enters into force at a time when it becomes legally binding for the parties to the treaty. A treaty does not enter into force when it is adopted. The date of entry into force may be a date specified in the treaty or a date on which a specified number of ratifications, approvals, acceptances or accessions have been deposited with the depositor. The date of entry may often be at a specified time mentioned in the treaty following its ratification or accession by a fixed number of states.
Evaluation criteria	are the entries appearing in column 4 of the STCW Code (Appendix III). These criteria provide the means for an assessor to judge whether a candidate can perform related functions or not.
Flag state	is the state under whose laws a commercial vessel is registered or licensed.
Flue gas generator	refers to machinery on board marine tankers that draw inert gas from the boiler systems of the ship.
Functions	means a group of tasks, duties and responsibilities, as specified in the STCW Code, necessary for ship operations, safety of life at sea or protection of the marine environment.
IMO Model course	The IMO has designed the series of courses to help implement the STCW Convention and, further, to facilitate access to the knowledge and skills demanded by increasingly sophisticated maritime technology. The purpose of the IMO Model courses is to assist maritime training institutes in organizing and introducing new training courses, or in enhancing, updating or supplementing existing training material.
Inert gas	A gas that under given conditions does not undergo chemical reaction. In the maritime context it is often nitrogen which in the

	tanker handling area is used to control atmosphere in the cargo tanks.
Inert gas generator	refers to machinery on board marine tankers. Inert gas generators consist among other things of a burning chamber. Atmospheric air is burned so that it contains less than 5% oxygen, thereby creating inert gas.
Inerting	means the introduction of inert gas into a tank.
Party	means a State for which the Convention has entered into force.
Pingpong	is a learning management system; a web-based learning platform and course administrative tool.
Rating	means a member of the ship's crew other than the master or an officer.
Replacement method	is a layering process of inerting. Lighter gas (inert gas) enters at the top of the tank and the heavier gas (hydro carbon gas) is displaced from the bottom of the tank through some suitable piping arrangement.

LIST OF FIGURES

1 INTRODUCTION

Qualified personnel are important in every industry, but in the maritime sector you are to a greater extent dependent on the competence of the persons serving on board. In an historical aspect the level of competence has been handled by the seafarers themselves or on a regional or national basis, which has meant that the level of training and competence of the seafarers could vary greatly. During the seventies, the International Maritime Organization (IMO) answered the call of adopting a more international standard which led to the STCW Convention (Standards of Training, Certification and Watchkeeping for seafarers) being proposed for the first time. (IMO, 2012)

1.1 BACKGROUND

In modern merchant shipping you must, in order to be able to work in a position on board a vessel in international trade, hold a number of certificates depending on the ship type. To be eligible as a candidate for such a certificate you have to demonstrate the competence to undertake the tasks, duties and responsibilities connected to the certificate in question. The STCW Convention is the statutory text that regulates which kind of training and what certificates a person must hold to serve in different positions on board. The STCW Convention also, among other things, provides approved education providers with methods for how the candidates can demonstrate their competence. Examples of these methods can be approved in-service experience or approved simulator training. All methods available are provided in column 3 of the STCW Code (See Appendix III). (IMO, 2011)

Since the first STCW Convention entered into force in 1984, it has been revised several times. The latest revision was made in 2010. It is known as the Manila amendment and entered into force in January 2012. Changes in the STCW Convention have a major impact on national legislation and also how education within the maritime field is conducted and evaluated. (Transportstyrelsen, 2011)

One of the earlier major revisions, STCW 95, shifted to a more proficiency-based examination from an earlier one based on knowledge. The Manila amendment has continued in that spirit and also embraced modern and upcoming technology. The Convention offers a range of different methods for testing, both practical and written. Practical testing may include training ships, a simulator or a merchant ship. If a simulator is used, strict standards are outlined in the code. Chapter 1 of the code covers the performance standards of simulators, procedures for simulator-based training and assessment as well as the qualifications of instructors and assessors. (Smith Robson, 2007) In addition to the general performance standards (see Figure 1) the Code also specifies what training procedures that should be used and that the party shall ensure that the simulator-based training is defined within an overall training programme. The Code also says that the instructors and assessors are appropriately qualified and experienced for the types and level of training and assessment of competence that are specified in the regulations (IMO, 2011).

In Chapter V of the STCW Code, *Standards regarding special training requirements for personnel on certain types of ships,* provides minimum requirements for the training and qualification of masters, officers and ratings on oil and chemical tankers. Tables included in the chapter (See Appendix III) outlines the criteria for evaluating competence of those standards according to two functions, basic or advanced training for tanker operations (IMO, 2011)

For every competence listed in the tables there are also methods for demonstrating competence and the criteria for evaluating the competencies. For example, column 2 in Table A-V/1-1-2 tells us that as one of the minimum standards in advanced training for oil tanker operations a candidate should have proficiency in tanker safety culture and implementation of safety-management systems. One of the permitted methods for demonstrating competence in this field is approved simulator training. In column 4 in the table there is also criteria provided for evaluating competence which in this case might be that cargo operations are planned and

the risk is managed and carried out in accordance with accepted principles and procedures to ensure safety of operations and to avoid pollution of the marine environment. What the code does not provide is detailed tools on how these criteria should be evaluated. As Smith Robson points out in her research:

"Although the IMO provides limited guidance on methodologies to be employed for assessment of mariner skill, it does not offer detail with respect to specific evaluation techniques." (Smith Robson, 2007)

These tools are now left to the assessor to develop in accordance with the parameters outlined. Smith Robson also highlights that the collective of marine educators would gain from an international collaboration towards a standardization of mariners' competency assessment (Smith Robson, 2007). Each competence is also connected with a degree of requisite knowledge, understanding and proficiency. These denominations correlate well with those used in the taxonomy for educational objectives (Anderson, Krathwohl, Airasian, & Cruikshank, 2001). Some competencies are easy to assess, whereas others call for extensive planning. When a simulator is used as a tool in the evaluating process there is often a need for a well-developed database. Different functions have different needs for the complexity of evaluation (Smith Robson, 2007).

Education is an ever developing process. This thesis will prove that the tanker-handling education at Chalmers University of Technology is in accordance with the latest international legislation, and, what is more important, that the efforts of incorporate modern technology in form of a cargo handling simulator will prove fruitful in terms of learning outcome for the students.

1.2 OBJECTIVES

The main objectives of this study are to:

- evaluate how new legislative demands have changed tanker education with an emphasis on the use of cargo-handling simulators; and
- answer the question on how well students reach the standard of competence formulated in the STCW Convention and Code within the tanker area.

1.2.1 RESEARCH QUESTIONS

- How have the legislative demands changed tanker education?
- Do the students reach the standards of competence formulated in the STCW Convention and Code within the tanker area?

1.3 LIMITATIONS

The study is limited to the petroleum part of the tanker-handling course at Chalmers University of Technology. The course (described in more detail in Chapter 2.4) is in compliance with the Manila amendment of the STCW Convention and should therefore have the same minimum standards of competence regardless of where the course is given. One part of the course is practical exercises in a cargo-handling simulator. The exercises are constructed to meet the course objectives. This study will not look at all exercises in detail but will focus on a few representative ones.

2 THEORY

This chapter will provide a theoretical framework for this master's thesis. The first part will account for the legislative demands that govern maritime education. The later part will describe the cargo-handling simulator and the tanker-handling education (petroleum/chemical) at Chalmers University of Technology. Finally, the connection between the STCW Code's knowledge, understanding and proficiency (see column 2 Appendix III) and established taxonomies for educational objectives will be explained in detail.

2.1 THE STCW CONVENTION, THE MANILA AMENDMENT

In 1978, the first STCW Convention was adopted in order to establish an international level of requirements for training, certification and watchkeeping for seafarers. Previously, those standards were stated on a national level by individual governments, usually disregarding practices in other countries. This resulted in standards varying a lot from country to country even though shipping is considered to be the most international of all industries. (IMO, 2012)

The STCW Convention entered into force in April 1984. Since then, amendments thereto have been adopted several times with major revisions in 1995 and now the most recent one in 2010. (IMO, 2011)

The 1978 version of the Convention was criticized for many vague phrases which led to different interpretations being made and being out of date. The 1995 amendments represented a major overhaul of the Convention, in response to the criticism. One of the major changes was the division of the technical annex into regulations and a new STCW Code to which many of the technical regulations were transferred. Essentially, the Convention consists of general requirements which are described and explained in more detail in the STCW Code. The STCW Code is divided in two parts: Part A which is mandatory and Part B which is recommended. The main reason for the new form was to make administration easier and also make the tasks of updating and revising more simple. (IMO, 2012)

The early versions of the Convention were also criticized for putting too much emphasis on the traditional shipowner in-house cadet training programme. The Convention provided good coverage of knowledge and understanding whilst the acquisition of practical skills was left to the on-board training. The traditional shipowner programmes were declining and coupled with a general reduction in the seafaring experience of mariners, there was a call for a revision of the STCW Convention, which put a greater weight on the acquisition of practical skills. (Muirhead, 2004)

Another objective that the IMO wanted to accomplish with the revision of the code was to put higher pressure on the flag state. The IMO wanted flag states to provide more detailed information on measures taken to ensure compliance with the convention. Generally, it is up to the flag state to handle the implementation whilst the port state also acts to ensure compliance. Under the revised STCW Convention, flag states were to provide information on education and training, certification processes and other information relevant to the implementation of the Convention. The IMO reviewed this information and produced a list of the flag states in compliance with the STCW Convention. (IMO, 2012)

In June 2010, it was time for another major revision in order to keep the Convention and Code up to date. In the work with the revision, the IMO also tried to address the issues to be expected to emerge in the future. This revision of the Convention is called the Manila amendments and entered into force on 1st January 2012. (IMO, 2012)

Among the changes adopted there are several important changes to each chapter of the Convention and Code, including:

- Improved measures to prevent fraudulent practices associated with certificates of competency and strengthen the evaluation process (monitoring of Parties' compliance with the Convention);
- Revised requirements on hours of work and rest and new requirements for the prevention of drug and alcohol abuse, as well as updated standards relating to medical fitness standards for seafarers;
- New certification requirements for able seafarers;
- New requirements relating to training in modern technology, such as electronic charts and information systems (ECDIS);
- New requirements for marine environment awareness training and training in leadership and teamwork;
- New training and certification requirements for electro-technical officers;
- **Updating of competence requirements for personnel serving on board all types of tankers, including new requirements for personnel serving on liquefied gas tankers;**
- New requirements for security training, as well as provisions to ensure that seafarers are properly trained to cope if their ship comes under attack by pirates;
- **Introduction of modern training methodology including distance learning and web-based learning;**
- New training guidance for personnel serving on board ships operating in polar waters; and
- New training guidance for personnel operating Dynamic Positioning Systems. (IMO, 2012)

The updates marked in bold are especially important to this work. The introduction of modern training methodology allows the use of simulators for demonstrating competency to a much greater extent than before, and the update of the competence requirements for personnel serving on board tankers naturally calls for an update of the curriculum of tanker-handling education.

2.1.1 OTHER LEGISLATIVE DEMANDS

The IMO as an inter-governmental organization has no jurisdiction to implement laws on a national level. As a part of the process when a party ratifies a Convention it declares the intention of implementing the Convention in its national laws.

In Sweden, it is the Swedish parliament which is the body that decides on new laws. New or changes in existing laws are proclaimed through the Swedish Codes of Statutes (Svensk författningssamling, SFS). When there is a change in an international treaty that Sweden has ratified there also has to be a change in the Swedish legislation. To adjust to the Manila amendment to the STCW Convention, the Swedish parliament updated the existing regulation of competence for seafarers (Förordning om behörighet för sjöpersonal, SFS 2011:1533). The Swedish parliament and government also have the possibility to authorize parts of the administration to give more detailed regulations on the topic. In the case of education and competence for seafarers it is the Swedish Transport Agency (Transportstyrelsen) that issues regulations. These regulations are the regulations and guidelines on training and qualifications of seafarers. (Föreskrifter och allmänna råd om utbildning och behörigheter för sjöpersonal, TSFS 2011:116) (Regeringskansliet, 2012)

The above-mentioned regulations also contain details on tanker education. In previous regulations the Swedish Transport Agency (formerly known as the Swedish Maritime Administration) directed the content of tanker handling in great detail. The modern legislation (TSFS 2011:116) basically states that tanker-handling education should comply with the STCW Convention.

2.2 TAXONOMY OF EDUCATIONAL OBJECTIVES

There is a well spread and well accepted taxonomy of educational objectives created in the 1950's by the educational psychologist Benjamin Bloom. The taxonomy, usually referred to as Bloom's taxonomy, categorizes skills and objectives for students. Educational objectives are divided into three major domains: the cognitive, the psychomotor and affective domain. When it comes to educational objectives within the mariner's area, the cognitive area is the most relevant. The cognitive area constitutes, among other things, skill objectives of knowledge, comprehension and application. These objectives correlate very closely to those of the STCW Code: knowledge, understanding and proficiency. (Anderson, Krathwohl, Airasian, & Cruikshank, 2001)

- **Knowledge**
  - When it comes to cognitive levels, knowledge is considered to be the lowest. In this sense knowledge only requires that the student can recall previously learned material like facts, basic concepts and terminology. For example, this can be knowledge of the standard representational symbols used on charts or terminology used when mooring. Test of such knowledge can easily be achieved through written exams.

- **Understanding**
  - The level of understanding or comprehension requires a deeper understanding of facts and ideas, which can be shown by interpretation and description. For example, a trainee might be shown a picture of a centrifugal pump and be asked to describe the concept on how the pump operates. Testing of comprehension can also be achieved in written format but would require more elaborate answers than just short ones.

- **Proficiency**
  - Proficiency is the highest of the skill objectives in the STCW Code. To demonstrate proficiency you have to apply acquired knowledge. To do this a student can, for example be asked to perform a shipboard operation like taking in ballast. The best way to assess application of acquired knowledge would be to demonstrate proficiency through practical examination. Here, a simulator can prove to be a very valuable tool. A simulator that fulfils the performance standards for simulators used in the assessment of competence required by the STCW Convention should permit an assessor to control, monitor and record exercises for the effective assessment of the performance of candidates (see Figure 1) (IMO, 2011). The more technical and practical demands of the simulator are specified in the DNV standards 2.14 (DNV, 2012)

2.3 TANKER-HANDLING SIMULATOR

The previous chapters conclude the more detailed legislative part and the pedagogical foundation of this thesis. The following chapters will be of a more practical orientation.

2.3.1 DEFINITIONS AND CLASSIFICATION

What is a simulator? There is a wide range of answers to this question. In the scope of this paper, a simulator should be viewed as a device that duplicates limited aspects of the real world. The simulation process itself benefits from aspects such as avoiding cost and risk associated with the running of a real system, avoidance of damage to health, property and environment, and, obviously, repeatable and monitorable exercises. (Cross, 2011)

The IMO has a working group (Intersessional Simulator Working Group, ISWG) which was established to structure and organize the matters related to simulators for inclusion in the STCW revision (Cross, 2011). One of the definitions adopted by the ISWG is:

"Simulation is a realistic imitation, in real time, of any ship handling, radar and navigation, propulsion, cargo/ballast or other ship-system incorporating an interface suitable for interactive use by the trainee or candidate either within or outside of the operating environment, and complying with the performance standards prescribed in the relevant parts of this section of the STCW Code." (IMO ISWG, 1994)

In the STCW Convention and Code the use of simulators is referred to in several places. There are general performance standards for simulators used in the training and assessment of competence as well as other provisions for training and assessment procedures (See Figure 1). Some simulator training is considered essential and is therefore mandatory for complying with the STCW Convention. Mandatory training in simulators is Radar and ARPA training and special conditions apply to these kinds of simulators. (IMO, 2011). The Cargo- Handling Simulator (CHS) is not incorporated under these rules so it will not be viewed in detail. Still, it is up to each party to ensure that every simulator used in the training and assessment of competence required under the convention fulfils the performance standards. To aid maritime administrations with this work, the class society Det Norske Veritas (DNV) has developed classification rules for maritime establishments. So, if a maritime simulator complies with standards of certification No. 2.14 Maritime Simulators, it is considered to comply with the performance standards listed in the STCW Convention. (DNV, 2012)

General performance standards for simulators used in the assessment of competence

Each Party shall ensure that any simulator used for the assessment of competence required under the Convention or for any demonstration of continued proficiency so required shall:

- **be capable of satisfying the specified assessment objectives;**
- **be capable of simulating the operational capabilities of the shipboard equipment concerned to a level of physical realism appropriate to the assessment objectives, and include the capabilities, limitations and possible errors of such equipment;**
- **have sufficient behavioural realism to allow the candidate to exhibit the skills appropriate to the assessment objectives;**
- **provide an interface through which the candidate can interact with the equipment and simulated environment;**
- **provide a controlled operation environment, capable of producing a variety of condition, which may include emergency, hazardous or unusual situations relevant to assessment objectives; and**
- **permit an assessor to control, monitor and record exercises for the effective assessment of the performance of the candidates.**

FIGURE 1: GENERAL PERFORMANCE STANDARDS FOR SIMULATORS USED IN ASSESSMENT OF COMPETENCE. (IMO, 2011)

The cargo-handling simulator at Chalmers is classified by DNV and is therefore considered to meet the requirements of the STCW Convention.

2.3.2 SIMULATOR TRAINING

Simulators are more and more replacing the in-service training of seafarers, and the revision of the STCW Convention gives the training conducted in simulators an increased importance (Ali, 2006). The simulator is a training tool which needs to be integrated into a training programme. The simulator should be used for training normal and emergency procedures, especially those procedures that cannot be trained in real life due to risks or high costs. (Cross, 2011)

There has been progress in the electronics industries that has positively affected the development of simulators for specific marine applications. Simulators of different types become more available for a wider

group of users. (Cross, 2011) Still, new technology must be viewed as a complement to traditional education, not a replacement. The programme objectives are crucial in a simulator-based system. It is a challenge for the lecturer to determine where technology can enhance or improve the learning situation. The programme objectives should be a guide for directing the students and teachers towards the desired training objectives. (Muirhead, 2004) (Cross, 2011)

2.3.3 VALIDATION OF SIMULATOR TRAINING

The simulator as a tool in a learning process needs to be validated in an aspect of how well the tool aids the attaining of learning objectives. When it comes to the assessment of simulator training the evaluation has been inadequate. As Cross points out in his research this is partly due to the difficulty of agreeing on acceptable international standards and partly due to the complexity of simulator exercises. At least validation should include inspection and approval of the training programme, methods and facilities used and assessment system. (Cross, 2011) The Swedish Transport Agency validates institutes that provide training in the maritime sector.

In general, most educational efforts will include some part of evaluation and assessment to control if the set objectives have been met. In the revised STCW Convention the assessment of skills has been more tightly linked to the evaluation of competencies. Competence-based training can, with a good outcome, be evaluated on the training tool that has been used. The complexity of the task also matters; the method of evaluating simple tasks like donning a lifejacket obviously differs from the method when evaluating a more complex task like the loading of a multigrade cargo. In the case of a more complex skill a vessel or a tool used to represent the vessel, a simulator, can be used. (Cross, 2011)

When evaluating student performance in a simulator, it is essential to have a set of standards or criteria to match the achievements with. Setting these criteria is complex and sometimes quite difficult. There are many factors that may influence and the criteria may even change over time. Input on the criteria may be acquired in many different ways; the assessor's previous experience, previous results, international standards, peer results, etc. Apart from the problem of applying test methodology and setting criteria there is also a problem with objectivity. If accepted parameters are matched to criteria and are monitored by a computer in a simulator this will lead to an instantaneous and objective evaluation. As a contrast, if the assessor compares performance with set standards, unstructured and without verification, there is always a risk for a more subjective opinion. (Cross, 2011)

Having a good and transparent evaluating method is a quality indicator for the education (Cross, 2011). Methods for objective assessing have been developed and have gained wide-spread acceptance over the years. Elements required for proper evaluation according to Reay is:

- Methodology (how to evaluate and with which tools)
- Objectivity (outcome not influenced)
- Criteria (which outcome is required)
- Reliability (measurement consistency)
- Validity (measure what is intended)
- Fidelity (accuracy in reproduction of simulated process)
- Reality (impression has physical and behavioural realism) (Reay, 1994)

The tanker handling simulator at Chalmers is equipped with an instructor's program that enables the possibility of computerized assessments, among other things. How these assessments are constructed will be described under 2.4.2 - assessing simulator exercises.

2.4 THE TANKER-HANDLING COURSE

The tanker-handling course (Sjötransport av tanklaster) at Chalmers University of Technology is underlying the application for certificate of competence for oil and chemical cargo handling and the certificate of service on tankers in accordance with Regulation (2011:1533) of competence for seafarers. The course is a mandatory part of the master mariner's training programme. As the course has provided a basis for a certificate of competence, the course has been compulsory in all components by demands from the Swedish Transport Agency. With the new legislation in force from the 1st of January 2012 the demand of mandatory attendance has been removed from the national legislation. Formerly, the Swedish Transport Agency had detailed recommendations on the course scope and content, while it now only requires that the course is in compliance with Chapter V of the STCW Code. (Näringsdepartementet, 2011) It might be added that it is not yet decided if the Swedish transport agency will demand that providers of maritime training will have to follow the IMO Model courses in respect to the time scale.

The course runs over 8 weeks and the work that the students are expected to put in is approximately around 200 hours divided into:

- 14 Lectures, 56 hours
- Own studies, 116 hours
- 6 Simulator exercises, 24 hours
- Written exam, 4 hours

The course includes, but is not limited to:

- Oil and chemicals, physical and chemical properties;
- Legislative demands and documentation;
- Design and characteristics of tankers;
- Cargo calculations;
- Tanker system knowledge and handling;
- Risks, hazards and safety connected to tanker handling; and
- Precautions to prevent pollution of the environment.

The course curriculum also includes the demands from the National Agency for Higher Education (högskoleverket) that states that a graduate student of the master mariner's programme should:

- show such a wide maritime technical knowledge that is necessary to, in a senior management position, be operationally responsible for crew, ship and cargo;
- be able to serve in positions up to commander, especially on tank, passenger and roll-on/roll-off ships; and
- demonstrate an ability to manage products, processes and work environment with regard to human conditions and requirements of our society's goals of economic, social and ecological sustainability.

After successful completion of the course and having met attendance demands, the student will be given a pass grade, but if not all requirements are fulfilled it will result in failing the course. (Cargo operations, 2012)

2.4.1 SIMULATOR EXERCISES

Section A-I/12 of the STCW Code provides the standards governing the use of simulators. The chapter provides details on the performance standards of the simulator (see Chapter 3.2) as well as guidance on training and assessment procedures. Regarding simulator-based training, the code says that the aims and objectives of the training shall be defined within an overall training programme. Specific tasks and objectives shall be selected so that they relate as closely as possible to shipboard task and practices. During simulator-based training the instructor shall also ensure, among other things, that:

- Trainees are adequately briefed on the exercise objectives;
- Trainees have adequate familiarization time on the simulator;
- Exercises are monitored from start to end;
- Trainees are effectively debriefed to ensure that training objectives have been met; and
- Simulator exercises are designed and tested so as to ensure their suitability for the specified training objectives. (IMO, 2011)

At Chalmers there is a continual effort to try to improve learning experience for the trainees. As a part of this effort, at the end of all courses, there is a course evaluation form sent out to all students. As a result of this the Manila amendment opens up for the use of a simulator as a method for demonstrating competence, and by public demand for more simulator exercises that have emerged from the course evaluations the tanker handling course has doubled its simulator exercises from previous years. This year, there is a total of six simulator exercises all scheduled for four hours. The exercises can also be divided into sub-task or part-tasks. Below follows a description of all the exercises:

1. **Familiarization**
    - This exercise gives a thorough walk-through of the simulator functions and sub-systems. It also gives knowledge about different types of tankers, general arrangements and construction. The trainees are also introduced to different logs and checklists used within the tanker-handling area. Furthermore, it gives the trainee adequate time to become familiarized with the simulator.
2. **Tank atmosphere**
    - Control of tank atmosphere is in many cases crucial when it comes to liquid cargo handling, both in relevant cargo-related hazards as well as safe working practices for personnel. The tank atmosphere exercise is divided into three different part-tasks. The first two cover inert gas systems, inert gas composition and different techniques for inerting tanks, and the third part-task which covers ventilating tanks, tank entry and health hazards connected to tank atmosphere.
3. **Loading of petroleum cargoes**
    - The exercises follow a plan of increasing complexity. The more familiar the trainees become with the simulator the more systems and tasks are incorporated into the exercises. When it comes to the loading of cargo, the functions required are not covered in total by chapter A-V in the STCW Code. Many functions required are covered by the A-II which deals with functions of general cargo handling on operational and management levels. The specific exercise is divided into two part-tasks: loading of homogenous cargo and loading of multigrade cargo with cargo separation.
4. **Unloading of petroleum cargoes**
    - Unloading of cargo is one of the tasks that demand the most of the ship and its personnel. Most shipboard systems are active and many details need to be surveyed. The last exercise of the “oil package” is divided into two part-tasks, the first is a discharge of a homogenous crude cargo, and the second part-task is a discharge procedure that also includes crude oil washing (COW) and stripping.

These exercises connect well to several functions within the STCW Code table A-V/1-1-1 and A-V/1-1-2. The more complex exercises (nos. 3 & 4) also cover functions from table A-II/1, A-II/2 and A-II/5 (see Appendix III). In addition, the exercises contribute to fulfilling the goals stipulated by the National Agency for Higher Education.

5. **Cargo planning Chemicals**
    - Due to their chemical properties some chemicals are bound to react with each other, with water or oxygen in the air. It is crucial for personnel on cargo tanker to be aware of the complexity and hazards with carrying chemicals. This exercise trains the candidates in chemical cargo planning with available computer support, such as chemical databases, etc.
6. **Tank washing Chemical tanker**
    - This exercise highlights different cargo needs for tank cleanliness and different methods and techniques to achieve that. The exercise also includes regulations and techniques related to pre-wash, and finally, the exercise also includes the environmental legislation connected to the discharge of wash water from chemical tankers.

There are many common features in ship system between oil and chemical tankers, so many of the exercises designed for an oil tanker will prove valid for a chemical tanker as well. In this case, the simulator interface is the same and physical modelling and pumps, pipes, etc., can be expected to behave in the same way. As an aspect of the common systems in oil and chemical tankers the exercise covers, in addition to the tables in the STCW Code mentioned above, also table A-V/1-1-3 (see Appendix III).

All exercises in the oil and ship type independent package (nos. 2 - 4) followed the same structure. Before and during all exercises, there was a written exercise instruction available. The exercise instruction was distributed through the electronic course platform Pingpong. The instructions contained, in addition to general information, also learning objectives, tasks and references to relevant STCW tables. Every set of exercises started with a concerted briefing of what the different exercises contained and where more information in the course literature could be found. The exercises were performed in pairs of students. After each task, there was a debriefing for every group. During these debriefings there was a discussion about the group performance to ensure that the learning objectives had been reached. As a basis for this discussion the assessment protocol from the simulator was used.

2.4.2 Assessing simulator exercises

When assessing simulator-based exercises, the assessor must assure that performance criteria are clear and transparent. This is to ensure that assessments can be made with the uniformity and reliability that is necessary for achieving an evaluation where subjectivity from the assessor is kept to a minimum. The trainees who are to be assessed must have an understanding of the criteria by which their competency will be determined. The candidates must also have received proper training and familiarization time of the equipment being used. Finally, the person being assessed must be adequately briefed and the tasks and skills must be assessed. (Smith Robson, 2007)

The STCW Code also provides information on the assessment procedures. In addition to the items that Smith Robson points out, the Code also suggests that methods for scoring and grading should be used with caution until properly validated and that the prime criterion is that the candidate demonstrates the ability to carry out a task safely and effectively to the satisfaction of the assessor. (IMO, 2011)

It is beyond the scope of this master's thesis to describe in detail the assessing of every exercise in the tanker-handling education at Chalmers. A few representative assessments will be presented in the chapter Results. The following paragraphs will cover the technology for assessment included in the simulator instructor system.

The tanker-handling simulator at Chalmers is equipped with an instructor's program. One of the functions of this program is the possibility to create automated assessments. All readings, inputs and outputs in the simulator are possible to monitor. For every parameter that one wishes to monitor, it is possible to create a trigger. The trigger operates through logical functions against predefined values set by the instructor. Figure 2 is an example of a simple trigger that monitors the oxygen content in the inert gas main line. To the right in the figure there are two values, the upper value is a value from the simulator while the lower value is the predetermined one. In this case, the industry standard says that a maximum oxygen content of inert gas delivered to tanks can be a maximum of 5 % (Oil Companies International Marine Forum, 2006). When the oxygen content monitored falls below 5 %, the trigger will be set off.

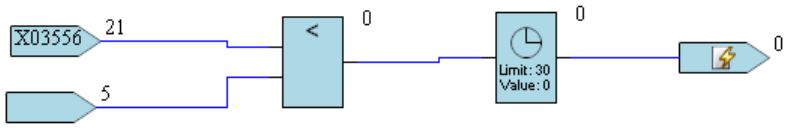

FIGURE 2: SIMPLE ASSESSMENT TRIGGER

These triggers can be connected to an event, action or an assessment in the instructor's program. For the scope of this thesis, the trigger will be used as an assessment function. It is possible to build a complex trigger consisting of many logical functions that monitor whole systems. An example of such a trigger is shown in Figure 3. The trigger monitors the oxygen content in the tank atmosphere in a whole cargo line system.

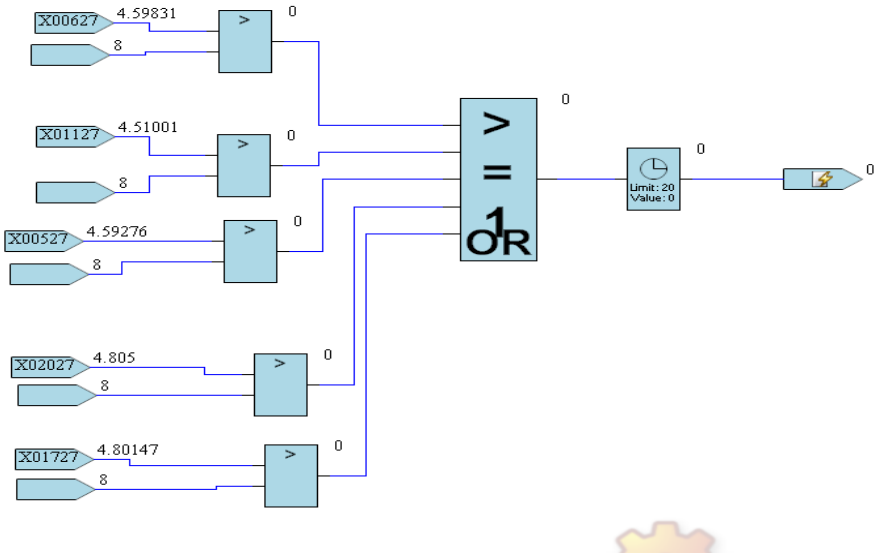

FIGURE 3: MULTI INPUT ASSESSMENT TRIGGER

When used as an assessment function, the triggers can be set to generate a positive or negative score. If multiple assessments are used all scores are added up to a total score. The instructor has the possibility to set the limit of the total score. All triggers connected to an assessment function are summarized in an assessment overview (see Figure 4).

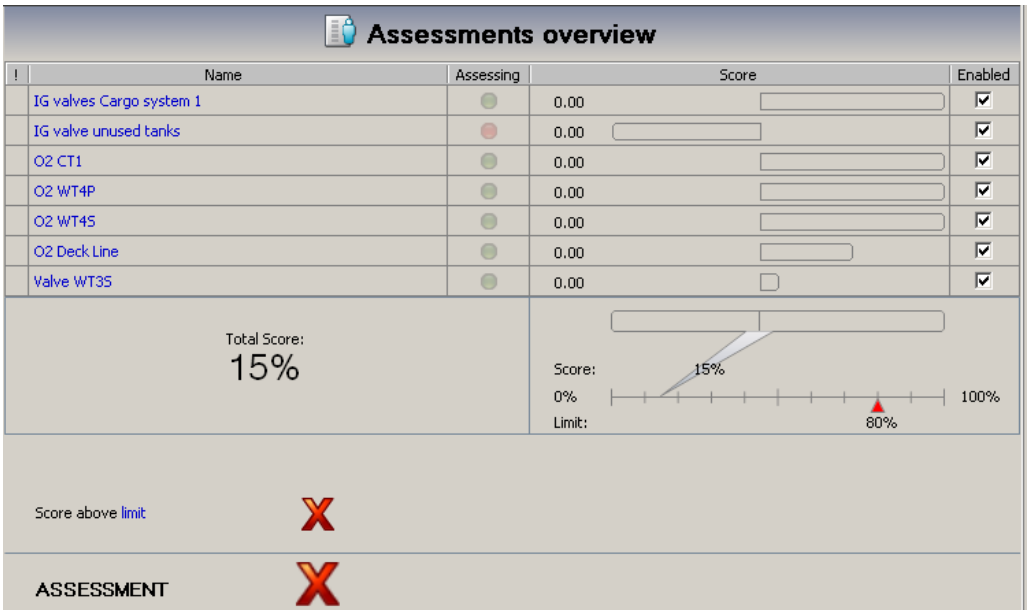

FIGURE 4: ASSESSMENT OVERVIEW FROM NEPTUNE INSTRUCTOR SYSTEM

The simulator assessment system provides several functions for proper evaluation named by Reay (see 2.2.3), especially objectivity and reliability can be fulfilled when using an automated system. (Reay, 1994)

3 METHODOLOGY

This thesis tries to attack its objective from many angles. Various techniques have been used for data collection in order to be able to triangulate the objectives in the best possible way. The methodology in this work is best described as action research. Action research is essentially practical and applied. Its purpose is to tackle "real-life problems" (Denscombe, 2009). Action research and the different techniques of data collection used will be described in more detail below.

3.1 PARTICIPANT CONSENT

In accordance with good ethical practise, the participants were informed about the research project from the start of the course. The information contained details about how and when the research were about to be conducted and who the researchers was. Furthermore, the participants were also informed about the purpose of the study and what they were expected to contribute with. (Denscombe, 2009) Before the study, the participants were asked to read and fill in a participant consent form. In connection with the signing of the form, information about the study was given again. The participants were also informed that they had the possibility of withdrawing their consent to participate in the study at any time. The written consent form can be found in appendix I

3.2 LITERATURE STUDY

At the start of this study, various pieces of information in the form of articles in journals and other academic literature assessed as being useful for the study was gathered. Websites from the IMO and other authorities were assessed in this study as being reviewed websites that have already undergone the evaluation of the information presented and considered to be of good quality. (Höst, Regnell, & Runeson, 2006) This more general search of the literature and articles provides an introduction, overview and general information and knowledge in the chosen subject and serves as a starting point for the study.

3.3 SURVEY

As a part of this study a survey was performed. The survey was directed directly to the target group; in this case the students of the course designated "The carriage of petroleum and chemicals in bulk". The survey was a web-based survey made available through the course administrative tool. The students participating in the course all have different background but are all attending the Master Mariner's Programme at Chalmers. The survey was accessible for seven weeks and contained eight questions in total. The students chose when and if they wanted to take the survey. Even though there are many parameters beyond the control of how and when the survey was performed, the level of standardization is estimated as being high (Trost, 2007). The survey questions in full are available in appendix I.

The purpose of the survey was to get a quantitative background of the students, as an aspect of age, gender, experience at sea and educational attainment (5 questions) as well as a qualitative part where the students' motivation and expectations of the course were sought (3 questions). In some aspects, the survey could be considered as an omnibus but for the purpose of the survey the level of structure should be considered as being high. The questionnaire was constructed so that as far as possible a common language was used and negations and personal values were avoided (Trost, 2007)

Two weeks after the survey had been made available, an email was sent reminding those who had not yet answered and thanking those who had participated. The participants were later reminded to fill in the survey in connection with lectures and exercises.

3.3.1 DROP-OUT ANALYSIS

The response rate was in total 63%, which could be considered as quite low for this kind of study with a very well defined target group. Normally, a slightly higher rate about 75% – 85% could be expected (Trost, 2007). The author can only speculate about why the response rate was as it was. In a later course evaluation, some students referred to a quite high workload in other courses. Still, the survey contributed with valuable background information and more important information about the student's motivation. In this aspect the survey is considered to have a high significance.

3.4 INTERVIEWS

To follow up what the students thought after the completion of their training a series of interviews were conducted. The interviews were performed at the end at the study period, but before the written examination had taken place. In total, seven students were interviewed regarding their opinion about the tanker-handling course, but with a special focus on the simulator training.

All the interviews were carried out at the Chalmers University of Technology, Campus Lindholmen, and the interviewer was Elisabeth Saalman from Engineering Education Research at Chalmers. An external interviewer was chosen so the students would not feel obstructed in expressing their opinions of the course.

The interviewees were chosen by the answers they submitted in the questionnaire at the start of the course and there was some effort made on choosing students with different backgrounds, age, gender and experiences in order to get as broad a perspective as possible in the answers. The questionnaire also provided the interviewer with a basis for the interviews.

The interviewer carried out the interviews in an open to semi-structured manner. (Höst, Regnell, & Runeson, 2006) There was a battery of questions that were decided upon and used, but the questions served mostly as input questions to start up the interviewee's freer "story-telling". The interviewee was not bound by fixed answers but was encouraged to discuss/describe the course and the simulator exercises with his/her own words. The interviews were recorded and reviewed material important to the thesis was transcribed. The outcome of the interviews will be accounted for in chapter 4.3.

3.5 ACTION RESEARCH

Since the rise of action research (AR), at the beginning of the 1940s, AR has usually been associated with small-scale research projects especially within social theory. Lately AR has gained in popularity as a research term method within the social sciences much thanks to its applications within organizational development, education, health care and social welfare. Given time, the research should not only give a better understanding of the formulated problem, it should also provide a momentum to actually change things. Usually, things change as a result of a research result - in AR the change is a part of the process. Summed up, AR has four characteristics features. (Denscombe, 2009)

- **Practical orientation**. The purpose of AR is to tackle "real" problems and research questions, mainly at workplaces and within organizations.
- **Change.** Change is to be considered as an integrated part of AR, both as a way of dealing with practical problems and for gaining a greater knowledge about phenomena and occurrences.
- **Participating.** The key persons in the process are the participants. They are active, not passive
- **Cyclic process.** AR contains the possibility to have a feedback loop where the initial results may be implemented and evaluated as a starting point for further research (see figure 5).

FIGURE 5: THE CYCLIC PROCESS OF ACTION RESEARCH

Some might claim that AR is more of a strategy than a specific method. The action researcher is not limited to a specific method of data collection, but may use different tool sets for the collection of data. AR is driven by the notion that change is something good. Change is considered to be a good way of learning how things work. For the action researcher change is accessible during the process rather than as a result of a research project. The main point is unlike classical research where an external expert observes and investigates a problem, in AR regardless of the methods chosen the action researchers own the process and can apply the knowledge gained during the process. (Denscombe, 2009)

The author has participated actively in the research in his role as a simulator instructor. The author created, led and assessed the simulator exercises 1 to 4 in the tanker-handling course. This enabled the possibility to observe how the students worked in the simulator environment, if there were any common problems with the exercises and engage in an on-going dialogue with students. The dialogue between instructor and student has provided a lot of information to aid the research, especially the debriefing gave insight in how the students reasoned around the exercises. Critical reflection is an important part of AR. In order to do this work the researcher has used a research diary, complemented by the methods mentioned above. The research diary was used as a support to bring systematics to the reflections and observations made during the project. Auto ethnography might also be used, or indeed every other applicable method or method blends (Styhr Petersen, 2010)). And, indeed, auto ethnography was used in the feature of describing the author's own views and working day. You could also say that, to a certain degree, this taking part in an observation was used but from the aspect of AR taking part in the project is essential, so this method will not be described further.

Action research is essentially practical and applied, driven by the need for solving "real" problems. As Kurt Lewin phrased it:

"Research that provides nothing but books will not suffice." (Lewin, 1946)

Only claiming to be practically oriented is not sufficient for distinguishing action research from other research disciplines, since many other disciplines can claim the same. In action research, research and application is tightly woven together. Since the processes are closely linked together the researcher must be deeply involved. This is one of the cores of action research. As stated by Edwards and Talbot:

“Professionals who are dedicated to explore aspects of their own practice when they are active in this practice.” (Edwards, Talbot, 1994).

It is not enough to conduct research as a part of work - to be true to the spirit of action research you have to research your own practice with the goal of changing it in a positive way. (Denscombe, 2009)

Bear in mind that AR can be considered as quite messy. Zuber-Skerrit and Fletcher find that:

“AR is open-ended, collaborative, situation specific, methodologically eclectic, and thus not prescriptive in its use of methods, processes or final goals.” (Zuber-Skerrit & Fletcher, 2007)

4 RESULTS

The tanker-handling course at Chalmers has a very specific objective.

"After the course the student should:

- meet the qualification requirements for the handling of cargo in ships carrying crude oil, petroleum products and chemicals in bulk according to the National Transport Agency regulations (2011:116) and guidelines on training and qualifications of seafarers." (Cargo operations, 2012)

How can it be shown that the student meets this objective? We know now that on a national level the National Agency of Transportation oversees the maritime education. The national rules refer to the international legislation, the STCW Convention. The National Agency of Transportation is also the authority that approves providers of maritime education. Chalmers is an approved provider of maritime training programmes. The STCW Code provides four different methods for demonstrating competence (see column 3 in Appendix III) and in the tanker education at Chalmers at least two different methods namely: written examination as a part of an approved training programme and approved simulator training are used.

4.1 WRITTEN EXAMINATION

Written examination has a long tradition at Chalmers and is considered to be a good way of assessing knowledge and understanding. The written examination of the tanker education course takes place at the end of an eight-week long study period. The test is made up of three parts, one part covering crude oil, petroleum products and general tanker knowledge, one part covering chemicals and the last part covering cargo calculations. The limit to pass the test is to score at least 60 % of the total score and have at least 60 % on each individual part. This means that the students are not allowed to achieve over 60 % of the total on just two parts. The maximum number of points was 115 distributed over the three parts with 77/24/14. Of the 57 students that took the exam, 56 passed (see Figure 6). More than half of the students (29 persons) scored over 90 % on the exam. In addition, 25 students scored between 75 – 90 % on the test.

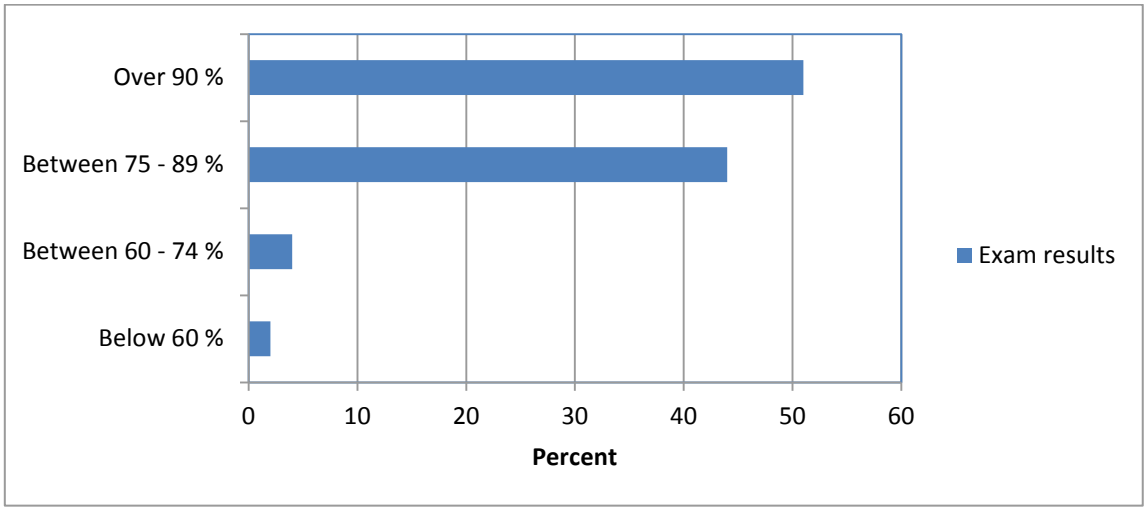

FIGURE 6: EXAM RESULTS

As earlier stated written examination is a proven method for assessing knowledge and understanding within the cognitive domain. The high rate of success on the written exam indicates that the students have assimilated a good knowledge and understanding within the tanker area.

4.2 PRACTICAL EVALUATION

When it comes to the assessment of proficiency, as mentioned earlier, the results from all exercises will not be covered. All exercises performed in the tanker-handling course were assessed, but all data will not be presented in this thesis. The exercise chosen to be examined in detail was exercise number 2 – Tank atmosphere. The exercise was chosen because it connects to several functions in the STCW Code (see Appendix III) and the control of tank atmosphere is crucial when it comes to preventing hazards and applying a safe working practice. Examples of competencies that include controlling a tank atmosphere are;

- Contribute to the safe cargo operation of oil and chemical tankers,
- Take precautions to prevent hazards,
- Ability to safely preform and monitor all cargo operations,
- Apply occupational and safety precautions,
- Take precautions to prevent pollution of the environment, etc. (IMO, 2011)

The exercise was divided into three different part-tasks. The arrangement on how the tasks where conducted follow the same structure. At first, a common briefing on the task, secondly after the briefing the students were set to manage the task in pairs of two and two. The times that the groups were not composed of even numbers, some of the students carried out the tasks on their own. Finally, after each task a debriefing was carried out with each group. During the debriefing, the group could discuss the results of their automated assessment and a more subjective assessment of evaluation criteria could be made. In addition to the automated assessment, video recordings of the selected tasks were also saved as a support for the evaluation of competence. The results of the automated assessments are as follows;

Part-task 1 – Inert gas system crude carrier, flue gas generator, dilution method.

In total, 30 groups performed the task. The total score limit was set at 80%. The average result was 74%. 10 groups did not reach the pre-set score limit in the automated assessment.

Part-task 2 – Inert gas system product carrier, inert gas burner, displacement method.

The total score limit was the same as in part task 1, 80%. In this part task the average result was 92.5% with 3 groups not reaching the pre-set limit.

Part-task 3 – Ventilation of tanks, fixed fans.

The average score in this exercise was 74% but in this exercise the limit of the total score was 60%. A few groups failed to complete the exercise within the scheduled time. In total, 5 groups did not meet the required total score on the automated assessment and included those who were forced to terminate the task due to insufficient time. Great emphasis on the application of occupational health, in terms of safe levels of oxygen and hydrocarbons for tank entry, was made during the debriefing.

The majority of the students proved their competence by meeting the standards of the automated evaluation process. Each group was debriefed but the groups that did not reach the predetermined score limit were asked to explain in greater detail their actions so a more subjective evaluation of the students' competence could be made. Some low scores could be explained by the fact that students are still unfamiliar with the simulator equipment. Where any ambiguity existed, video of the recorded task could be used to shed some light on the problem.

In the perspective of the delimitations of this thesis and the specific course objective of the tanker-handling course, the author believes that the students have met the qualification requirements.

4.3 RESULTS FROM SURVEY

The survey provided background information on the students like age, gender, educational background and sea-going experience (divided in tankers and other ships). The result that the survey provided that was deemed most important to this study was the results on the students' motivation and expectation on the course. The result from the survey question number 7 (see Appendix I) can be found in figure number 7. Some opinions brought up under the more free text description of the students' expectations on the course will be brought up under the chapter Discussion.

4.4 OBSERVATIONS FROM INTERVIEWS

The general opinion that is expressed from the interviewed students is that the simulator exercises are an appreciated element of the tanker education. Many thought that the practical point of view in the exercises helped them gain an understanding as to how the systems work and interact in "real life". Most sought after, however, were better and more detailed instructions for the exercises. The International Safety Guide for Tankers and Terminals (ISGOTT) is used as course literature and the students wanted a clearer connection between the literature and the assignments. This was to be able to be better prepared before the exercises. Some expressed criticism that the manual of the simulator was too extensive and difficult to read. They wanted to have page references in the exercises to the valid paragraphs in the manual. (Students, 2012)

Many of the interviewed students expressed an appreciation of the fact that the simulator exercises had been doubled since previous years, but they also requested even more time in the simulator, and, most important, the opportunity to practise in the simulator by themselves. Some also pointed out that if there was a possibility to practise on their own there would be a possibility to increase the demands placed on the students during the instructor-led exercises. (Students, 2012)

Several students expressed frustration over having to wait for a long time before getting any help from an instructor during simulator exercises and some tried to find information on their own while others resolved the problem by asking classmates. This also highlighted the need for instructions prior to the exercises. (Students, 2012)

The debriefing was a valued part of the exercises - many of the students claimed that the debriefing helped them to gain understanding (Students, 2012).

Some interviewees felt discouraged when they received negative score on their assessment, (see Figure 4) especially when they got stuck in an exercise and did not know how to progress. Sometimes they felt that they did not grasp what was expected of them, and that left them with the feeling of being incapable and thwarted. Some also referred to a lack of time, they did not manage to complete the exercises in the given time, which led to that they had to come back to finish the exercises another day. (Students, 2012)

A number of students also question the reality of the simulator (how well the simulator has a physical and behavioural realism). They mean that they can trick the simulator to perform operations that would not be possible in reality and that some functions do not correspond to "normal" function of equipment on-board tanker ships. (Students, 2012)

5 DISCUSSION

One of the great challenges as an educator is the students' motivation and the author believes that the motivation to participate in a course is tightly linked with the students' expectations on the same. The challenge lies within meeting the expectations of those who are highly motivated and reverse those with low expectations. Another challenge is to attune the education to a student group with very different levels of experience and background. Of the 37 students that answered the survey, the age range was between 20 to 46 years, they had served an average of 15 months at sea but only 5% had served more than 5 months on board a tanker. The survey was formed so that it would not only provide background information but also the students' expectations of the course. As shown in figure 7 most of the students were very motivated to take the course.

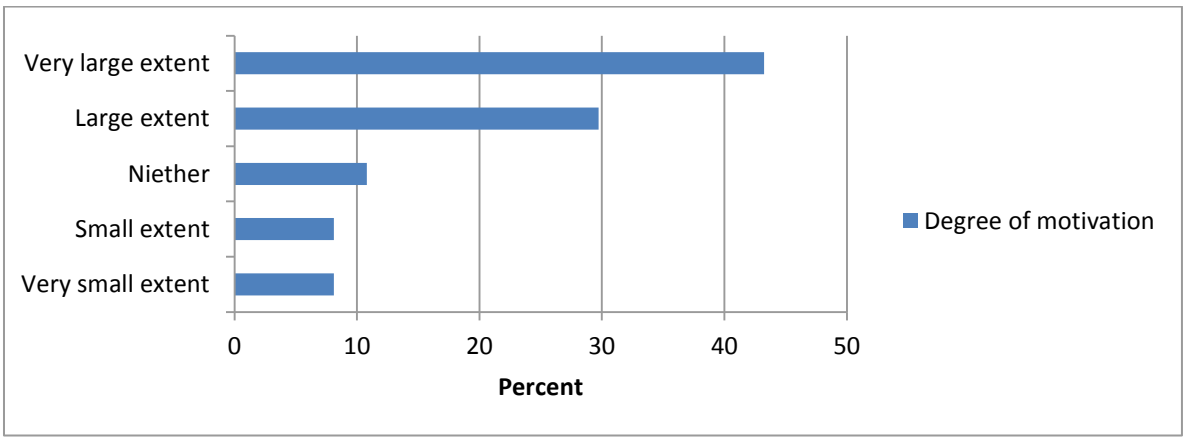

FIGURE 7: DEGREE OF STUDENT MOTIVATION

In question number 8 on the survey the students were asked to describe in writing expectations and what they had expected to gain by taking the course. These are some of the opinions expressed: (translated from Swedish)

"I only take this course because it is a mandatory part of the master mariner's programme."

"I'm looking forward to taking the course. I've done two training periods on a tanker ship and found the area interesting. I would consider working on a tanker after graduation."

"I hate tankers and have dreaded this course since the start of the programme. I want to finish the course as fast as possible but would prefer not to do it at all."

"I would like to gain so much knowledge that I would feel comfortable in serving as an officer on board a tanker."

"I would like to learn about the tanker trade since I have no experience in the area. I think it's going to be a useful and fun course."

Persons that have experience from tankers are generally more positive to tanker handling than those who have no experience. This may be because, in addition to the completion of the course at least 3 months of experience on a tanker is needed for being eligible for a tanker-handling certificate. Some people are not interested in tanker-handling or those who do not have the necessary experience might feel that the course is a waste of time. It can always be augmented if the tanker-handling course were to be a mandatory part of the master mariner's programme or not, but if you look at the demands from the National Agency for Higher Education (see 2.3), a knowledge of tankers is compulsory. Also if one considers the composition of the world's merchant fleet more than one quarter (27 %) are tanker ships (Svensk sjöfarts tidning, 2011). If you look at the same number in the fleet with the Swedish flag and/or Swedish owners, tanker ships is the largest segment

(approximately 200 ships) (Svensk sjöfarts tidning, 2011). These facts support the argument that tanker education should be a part of the Swedish master mariner's education.

After completing the course students are asked to fill out a course evaluation form. This evaluation forms a part of the constant attempt at developing the course, since the previous student input is an important part of the improvement efforts. This year's evaluation corroborates what has already been brought to light in a dialogue with students and has been confirmed in the interview series. The students are quite happy with the course. In the course evaluation, the course scored an average of 4.82 out of a maximum of 5. (Chalmers University of Technology, 2012) Some of the free text comments that the students made were: (translated from Swedish)

"Very good course and dedicated teachers which receive 5 out of 5 possible, keep up the good work with the excellent course"

"The teachers make even a boring subject as cargo handling, interesting" (Chalmers University of Technology, 2012)

This high degree of satisfaction of the students cannot, however, run the development to a halt. Several comments have been expressed by the students. In particular, the students have requested more exercises in the simulator and clearer exercise manuals. In an answer to these requests, improvement work has already been initiated. The exercise instructions are being revised with a much clearer link to course literature (ISGOTT) and simulator manuals. In addition, the exercise library is being developed to contain more exercises available to the students. Simultaneously, the changes necessary to make the simulator available to students in non-classroom time are being looked into.

When it comes to examination, the teachers of the course are quite content with the written examination. Written examination has a long tradition in higher education and works well for the testing of knowledge and understanding (Smith Robson, 2007).The practical examination works but would benefit from improvement. Time available and numbers of students/simulator stations are limiting factors in the practical demonstration of competence. This limiting factor is the reason for the students being paired in twos when they carry out the simulator exercises. The performance in the simulator is assessed as the performance of a group. This causes problems in determining with certainty individual competence. Statistically, it is possible for a student to slip through the assessment system by only relying on the competence of his/her partner. Great efforts have been made to ensure that it is not so but it is hard to objectively guarantee that this does not happen.

As stated in the STCW Code, the prime criterion is that the candidate demonstrates competency to the satisfaction of the assessor and this has been achieved in the tanker-handling course. If we take Reay's elements for proper evaluation into consideration, many of them have been fulfilled when working with the Neptune instructor system and the automated assessment available, but it is the author's firm belief that the exercises could be even more objective. Also, validity is an area where improvements could be possible. When new exercises are created they need to be peer-reviewed to a greater extent than what has been done so far in order to safeguard that they measure what is really intended. Furthermore, it is important that the programme objectives have been taken into consideration when creating exercises - the simulator exercises should be used to enhance student learning and have no intrinsic value taken out of context. The teachers and instructors must put great effort into how the simulator exercises can fit in and contribute to the course curriculum. (Cargo operations teacher team, 2011)

Another important factor, which must be taken into consideration, is how the learning process really takes place in the simulator. It is beyond the scope of this thesis to discuss in detail, the cognitive processes that take place when training in a simulator. The proficiency development that takes place during simulator-aided training would be an interesting area for further research.

Smith Robson points out in her research that the trainees who are to be assessed must have an understanding of the criteria by which their competency will be determined. (Smith Robson, 2007) There is some uncertainty if that really is achieved under the prevailing circumstances. Some of the interviewees say in the interviews that they do not read the learning objectives and course curriculum, they rely on the teachers to give them the correct information (Students, 2012). This can of course be true, but if the students do not seek information on their own it cannot be confirmed that they have fully grasped the full range of the criteria by which the will be assessed by.

Further, what also must be addressed is the frustration that some of the interviewees refer to when receiving negative scoring on the automated assessment. As stated earlier, the assessment should be used with discretion until it is properly validated. In the case with the simulator exercises in the tanker-handling course the automated assessment only forms a basis for the debriefing. The author thinks that it is unfortunate that the students are left with the feeling of inadequacy. The automated assessment is in many cases a quite dull instrument and the outcome of the assessment is without greyscale. The computer cuts at a specific value and does not have the possibility to interpret the result which makes the outcome of the assessment very black or white (in this case red or green). Although the automated assessment can be of great aid when it comes to objectivity there is still a need for an experienced instructor that can interpret the results and do a final assessment. The system would improve if there was a possibility to make the automated assessment non-emotive, if the scoring would be neutral instead of positive-negative, red-green, which it is today.

Finally, in the interviews, some of the students criticised the reality of the simulator (Students, 2012). The simulator has a well-documented physical model which is type approved by DNV. It is of the author's belief that the criticism rather is a misunderstanding of the simulator functions than a flaw in the simulator software. Of course, there are a lot of functions possible in the simulator that would not be possible in reality but that is one of the benefits with a simulator. You can pause and reflect on your actions, you can increase the time-factor and speed up time-consuming operations. This does not prevent the simulator to behave in a physical realistic way.

5.1 VALIDITY AND RELIABILITY

Validity and reliability should be and are major concerns for every scientist. Action research with its self-reflective nature deviates from the more traditional scientific schools, like positivism and quantitative science. This means that the action researcher faces an added burden in demonstrating validity and reliability. So how is it with this thesis? AR is of personal benefit to the researcher since it contributes to professional self-development and also adds value to continuous workplace-related improvement. AR also suits the small-scale project where the researcher is actively taking part, like the case in the work with this thesis. However, this research is limited by a quite narrow framework and is bound to the workplace, so the author does not claim that the findings of this thesis are transferable to a more general sphere. The data in this thesis is really only representative during the circumstances prevailing when the research was carried out. The author claims not to be impartial or objective to the research, which of course, might affect the conclusions.

All data, articles and information used have undergone scientific review and been assessed as being of good quality. The author has used a method blend, which is quite common in AR. It might be argued that reflective practice is more of an approach than a scientific method but as often in qualitative research there is nothing is either white or black. The author agrees with Reason & Marshall when they say:

*"*good research is an expression of the need to learn and change, to shift some aspect on oneself" (Reason & Bradsbury, 2006)

To summarize, the author draws the same conclusion as Styhr Petersen. Finally, it is up to the reader to judge whether the outcome of this thesis, when evaluated against the quality standards, has a valid and reliable claim.

5.2 SYNOPSIS

The legislation that controls tanker schooling has shifted from knowledge and understanding-based education to a training that attaches more importance to the acquiring of practical skills. This shift in legal demands challenges the providers of education to adjust and provide methods for their students to demonstrate competence. The tanker-handling simulator at Chalmers has proved to be a valuable tool in the evaluation process of the students' proficiency. The combination of a written examination and practical evaluation in the simulator provides a good ground for assessing whether the students have reached the qualification requirements or not. In the author's opinion, every student that has passed the course meets the requirements postulated by the STCW Convention and Code within the tanker-handling area.

To reach full capacity and to safeguard the objectivity and validity of the simulator exercises they need to be developed further and to a greater extent be peer-reviewed.

6 CONCLUSIONS

There has been a shift in the legislation that controls tanker education from a knowledge-based education to a more proficiency based one that puts a much greater emphasis on the acquisition of skills. This, in turn, has changed the demands on the maritime educators. To be compliant with the Manila amendment, the educators must have methods for the students to demonstrate competence. At Chalmers University of Technology the students in tanker-handling demonstrate their competence in a cargo handling simulator and their knowledge and understanding through a written examination. The assessment of competence is divided into two parts: a computer-assisted evaluation and a more subjective assessment made by the instructor. The system meets the demands but is a bit blunt and could be improved by a revision. To ensure objectivity and good quality it would be beneficial to limit as much as possible the more subjective judgment made by the instructor. This can be achieved by developing the computer-based system. In the combination of the written examination and assessment of practical exercises the students meet the demands that are required by the STCW Convention and Code.

The tanker-handling course is, in general, appreciated by the students but requests have been voiced to increase the time in the simulator, especially time to practise on their own. The students also sought a more explicit link between the course literature and the practical exercises.

6.1 FURTHER WORK

Action research is a cyclic process and this thesis has provided much feedback on how the tanker-handling course at Chalmers can be improved in the years ahead. This has resulted in an action plan that will be implemented during the next academic term. The action plan consist of simple things like printing the simulator manual in some hard copies, by request by the students, to more time-demanding processes like enhancing the exercise library, rewrite instructions and make the simulator available to the students off-hours. The thesis work has also raised other questions that could be processed in future research. Examples of such research is how can the gap between the methods of demonstrating competence and the criteria for evaluating competence in the STCW code be bridged? Other research topics can be; does the fidelity of the simulator affect how seriously the students take the exercise, what cognitive model is best applied for the training of maritime operations and how does the development of proficiency really take place in simulator-aided training? Also, how could the simulator software be developed to better suit the cognitive processes and better support an objective assessment?

REFERENCES

Ali, A. (2006). *Simulator instructor - STCW Requirement and reality.* Malmö: World Maritime University .

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., & Cruikshank, K. A. (2001). *A Taxonomy for Learning, Teaching and Assesing - a revision of Bloom's taxonomy for educational objectives.* New York: Longman.

Cargo operations. (2012, January 16). Sjötransport av tanklaster. Gothenburg, Sverige: Shipping and Marine Technology / Division of Ship Design.

Chalmers University of Technology. (2012, March 12). Kursutvärdering - Sjötransport av tanklaster. Gothenburg, Sweden.

Cross, S. J. (2011). Quality MET through Quality Simulator Applications. *International Conference IMLA 19.* Opatija.

Denscombe, M. (2009). *Forskningshandboken - för småskaliga forskningsprojekt inom samhällsvetenskaperna* (2:3 ed.). Lund, Sweden: Studentlitteratur AB.

DNV. (2012, April 11). Standards for certification No. 2.14 Maritime Simulation Systems. Høvik, Norway. Retrieved April 11, 2012, from DNV: http://exchange.dnv.com/publishing/StdCert/Standard2-14.pdf

Höst, M., Regnell, B., & Runeson, P. (2006). *Att genomföra examensarbete.* Studentlitteratur.

IMO. (2011). *International convention on Standards of Training, Certification and Watchkeeping for Seafarers.* London: International Maritime Organization.

IMO. (2012, March 26). *About IMO*. Retrieved March 26, 2012, from IMO: http://www.imo.org

IMO ISWG. (1994). *STW 26/inf, Sub-Commitee STCW.* London: IMO.

Laurillard, D. (1993). *Rethinking university teaching.* London: Routledge.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues, 2*, 34-46.

Muirhead, P. M. (2004). New Technology and Maritime Training in the 21st Century: Implications and Sulutions for MET Institutions. *WMU Journal of Maritime Affairs, 3*(2), 139-158.

Näringsdepartementet. (2011). SFS 2011:1533. *Förordning om behörigheter för sjöpersonal*. Sverige: Regeringskansliet.

Oil Companies International Marine Forum. (2006). *ISGOTT - International Saftey Guide for Oil Tankers and Terminals* (Fifth ed.). London: Whitersbys Publishing.

Reason, P., & Bradsbury, H. (2006). *Handbook of action resarch.* London: Sage.

Reay, D. (1994). *Evaluating Training.* London: Kogan Page.

Regeringskansliet. (2012, April 13). *Lagstiftningsprocessen, från iniativ till beslut*. Retrieved April 13, 2012, from Regeringskanslit: http://www.regeringen.se/sb/d/1522?setEnableCookies=true

Smith Robson, C. (2007). Towards an international Rubric: A Compilation of STCW Competency Assessment Methodologies. *8th IAMU Annual General Assembly* (pp. 247-257). Odesa: IAMU.

Students, o. t. (2012, February 28-29). Interviews of students studying the tanker handling course, Original source of interviews avalible at Engineering Education Research, Chalmers. (E. Saalman, Interviewer)

Styhr Petersen, E. (2010). *UserCentered Design Methods must also be User Centered: A Single Voice from the Field.* Department of Shipping and marine Technology. Gothenburg: Chalmers University of Technology.

Svensk sjöfarts tidning. (2011, September 23). Utflaggning pågår med oförminskad hastighet. *Sjöfartens bok*, pp. 136-140.

Transportstyrelsen. (2011). TSFS 2011:116. *Transportstyrelsens föreskrifter och allmänna råd om utbildning och behörighet för sjömän*. Sverige: Transportstyrelsen.

Trost, J. (2007). *Enkätboken.* Lund: Studentlitteratur AB.

Zuber-Skerrit, O., & Fletcher, M. (2007). The quality of an action research thesis in the social siences. *Quality Assurance in Education, 15*(4).

APPENDIX

APPENDIX I PARTICIPANT CONSENT FORM

Informerat samtycke

Denna studies syfte är att höja kvalitén på den praktiska utbildningen inom sjötransport av flytande bulk och att kontrollera att de bästa metoderna används för att samtliga studenter skall nå de utbildningsmål som regleras av gällande STCW konvention.

Under simulatorkörningarna kommer olika data att samlas in och du kommer att få svara på ett antal frågor i enkätformat. Ett urval kursdeltagare kommer också att bli tillfrågade om att delta i en intervju utförd av en lärare/forskare från Chalmers enhet Engineering Education Research som arbetar med pedagogisk utveckling av undervisning/lärande på Chalmers. Ditt deltagande I studien är frivilligt men vi hoppas att du vill ställa upp eftersom din medverkan är viktig för utveckling av kursen Sjötransport av tanklaster. Du är i studiens rapport helt anonym och inga data eller uppgifter kan spåras till dig som person.

Du kommer att genomföra övningar i en lasthanteringsimulator men övningarna genomförs så verklighetsnära som möjligt och enligt de regler som gäller i arbetslivet. Video och bilder kommer att spelas in under simulatorpassen. Samtliga inspelningar kommer enbart att användas för projektrelaterad dokumentation! Inspelade data kommer att helt anonymiseras; varken nu eller i framtiden kommer någon information du ger att kunna kopplas till dig som individ. Alla dina svar skyddas av offentlighetsprincipen och sekretesslagen [24 kap 8 § (2009:400)] och persondatalagen (1998:204). Chalmers ansvarar för all persondata.

Har du frågor eller kommentarer angående studien är du välkommen att kontakta ansvarig person, Olle Lindmark:

Testledaren har förklarat syftet med studien och jag har kännedom om de förutsättningar som är gällande. Jag har fått mina eventuella frågor besvarade på ett tillfredsställande sätt. Jag är medveten om att data och svar kommer att samlas in och analyseras. Jag vet om att jag när som helst kan avsluta min medverkan i studien utan att behöva ge någon förklaring.

Jag _____ samtycker och deltar frivilligt I studien.

Namn (textat)

Signatur: _____ Datum: _____

Jag ger härmed mitt medgivande till att bilder och video spelas in och lagras i samband med studien. Jag är medveten om att data kan komma att användas i presentationer och publikationer men att de då har anonymiserats och inte kan spåras tillbaka till mig själv.

Signatur: _____

APPENDIX II SURVEY QUESTIONS

Kursen Sjötransport av tanklaster håller på att ses över i syfte att utvecklas för att bättre anpassas till branschens behov.

Kursen bygger på internationellt och nationellt regelverk och består av fjorton föreläsningstillfällen och sex simulatorpass. Kursen avhandlar oljelaster såväl som kemlaster i bulk, efter avslutat kurs med godkänt resultat erhåll ett kursintyg. Detta kursintyg är ett del krav för utfärdande av specialbehörighet för tjänstgöring ombord på tankfartyg. För mer detaljerat kursinnehåll se kursbeskrivning och kurs-PM.

Vi ber dig besvara denna enkät för att bidra med information om studentgruppens sammansättning samt förkunskaper/erfarenheter som ni studenter har med er.

1. Ange ditt kön.
   Jag är _____Man/Kvinna

2. Hur gammal är du? Jag är _____år gammal

3. Hur många månaders sjötid har du? Hela månader, avrunda som du anser lämpligt. Har du ingen sjötid i nämnd kategori svarar du 0.
   Jag har_____månaders sjötid, varav_____ inom tanksjöfart. (olja, kem, gas)

4. Vilket program läste du på gymnasiet och hur många år omfattade programmet?
   Jag läste_____ på gymnasiet.
   Programmet var år_____ lång.

5. Har du någon eftergymnasial utbildning utöver den du genomgår nu?
   Jag har eftergymnasial utbildning _____Ja/Nej
   Om ja, vilken?_____

6. Har du i ditt arbete känt behov av att vidareutbilda dig? _____Ja/Nej
   Om du svarat ja på ovanstående fråga: Vad är det du känt behov av att lära dig mer om?
   _____
   _____

7. I vilken grad känner du dig motiverad att läsa kursen Sjötransport av tanklaster (se kursbeskrivning)?
   - I mycket liten grad
   - I ganska liten grad
   - Varken eller
   - I ganska stor grad
   - I mycket stor grad

8. Ge en kort beskrivning av dina förväntningar på kursen och vad du hoppas lära dig mer om genom att läsa Sjötransport av tanklaster.
   _____
   _____
   _____

APPENDIX III STCW TABLES

Table A-II/1 Function: Cargo handling and stowage at the operational level

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Monitor the loading, stowage, securing, care during the voyage and the unloading of cargoes	*Cargo handling, stowage and securing* Knowledge of the effect of cargo, including heavy lifts, on the seaworthiness and stability of the ship Knowledge of safe handling, stowage and securing of cargoes, including dangerous, hazardous and harmful cargoes, and their effect on the safety of life and of the ship Ability to establish and maintain effective communications during loading and unloading	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship experience .3 approved simulator training, where appropriate	Cargo operations are carried out in accordance with the cargo plan or other documents and established safety rules/regulations, equipment operating instructions and shipboard stowage limitations The handling of dangerous, hazardous and harmful cargoes complies with international regulations and recognized standards and codes of safe practice Communications are clear, understood and consistently successful
Inspect and report defects and damage to cargo spaces, hatch covers and ballast tanks	Knowledge[1] and ability to explain where to look for damage and defects most commonly encountered due to: .1 loading and unloading Operations .2 corrosion .3 severe weather conditions Ability to state which parts of the ship shall be inspected each time in order to cover all parts within a given period of time Identify those elements of the ship structure which are critical to the safety of the ship	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship experience .3 approved simulator training, where appropriate	The inspections are carried out in accordance with laid-down procedures, and defects and damage are detected and properly reported Where no defects or damage are detected, the evidence from testing and examination clearly indicates adequate competence in adhering to procedures and ability to distinguish between normal and defective or damaged parts of the ship

[1] It should be understood that deck officers need not be qualified in the survey of ships.

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Inspect and report defects and damage to cargo spaces, hatch covers and ballast tanks *(continued)*	State the causes of corrosion in cargo spaces and ballast tanks and how corrosion can be identified and prevented Knowledge of procedures on how the inspections shall be carried out Ability to explain how to ensure reliable detection of defects and damages Understanding of the purpose of the “enhanced survey programme”		

Table A-II/2 Function: Cargo handling and stowage at the management level

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes	Knowledge of and ability to apply relevant international regulations, codes and standards concerning the safe handling, stowage, securing and transport of cargoes Knowledge of the effect on trim and stability of cargoes and cargo operations Use of stability and trim diagrams and stress-calculating equipment, including automatic data-based (ADB) equipment, and knowledge of loading cargoes and ballasting in order to keep hull stress within acceptable limits Stowage and securing of cargoes on board ships, including cargo-handling gear and securing and lashing equipment Loading and unloading operations, with special regard to the transport of cargoes identified in the Code of Safe Practice for Cargo Stowage and Securing General knowledge of tankers and tanker operations Knowledge of the operational and design limitations of bulk carriers Ability to use all available shipboard data related to loading, care and unloading of bulk cargoes	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved simulator training, where appropriate using: stability, trim and stress tables, diagrams and stress-calculating equipment	The frequency and extent of cargo condition monitoring is appropriate to its nature and prevailing conditions Unacceptable or unforeseen variations in the condition or specification of the cargo are promptly recognized and remedial action is immediately taken and designed to safeguard the safety of the ship and those on board Cargo operations are planned and executed in accordance with established procedures and legislative requirements Stowage and securing of cargoes ensures that stability and stress conditions remain within safe limits at all times during the voyage

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes *(continued)*	Ability to establish procedures for safe cargo handling in accordance with the provisions of the relevant instruments such as IMDG Code, IMSBC Code, MARPOL 73/78 Annexes III and V and other relevant information Ability to explain the basic principles for establishing effective communications and improving working relationship between ship and terminal personnel		
Assess reported defects and damage to cargo spaces, hatch covers and ballast tanks and take appropriate action	Knowledge of the limitations on strength of the vital constructional parts of a standard bulk carrier and ability to interpret given figures for bending moments and shear forces Ability to explain how to avoid the detrimental effects on bulk carriers of corrosion, fatigue and inadequate cargo handling	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved simulator training, where appropriate using: stability, trim and stress tables, diagrams and stress-calculating equipment	Evaluations are based on accepted principles, well-founded arguments and correctly carried out. The decisions taken are acceptable, taking into consideration the safety of the ship and the prevailing conditions
Carriage of dangerous goods	International regulations, standards, codes and recommendations on the carriage of dangerous cargoes, including the International Maritime Dangerous Goods (IMDG) Code and the International Maritime Solid Bulk Cargoes (IMSBC) Code Carriage of dangerous, hazardous and harmful cargoes; precautions during loading and unloading and care during the voyage	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved simulator training, where appropriate .3 approved specialist training	Planned distribution of cargo is based on reliable information and is in accordance with established guidelines and legislative requirements Information on dangers, hazards and special requirements is recorded in a format suitable for easy reference in the event of an incident

Table A-II/5 Function: Cargo handling and stowage at the support level

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Contribute to the handling of cargo and stores	Knowledge of procedures for safe handling, stowage and securing of cargoes and stores, including dangerous, hazardous and harmful substances and liquids Basic knowledge of and precautions to observe in connection with particular types of cargo and identification of IMDG labelling	Assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 practical training .3 examination .4 approved training ship experience .5 approved simulator training, where appropriate	Cargo and stores operations are carried out in accordance with established safety procedures and equipment operating instructions The handling of dangerous, hazardous and harmful cargoes or stores complies with established safety practices

Table A-V/1-1-1 Specification of minimum standard of competence in basic training for oil and chemical tanker cargo operations

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Contribute to the safe cargo operation of oil and chemical tankers	Basic knowledge of tankers: .1 types of oil and chemical Tankers .2 general arrangement and Construction Basic knowledge of cargo operations: .1 piping systems and Valves .2 cargo pumps .3 loading and unloading .4 tank cleaning, purging, gas-freeing and inerting Basic knowledge of the physical properties of oil and chemicals: .1 pressure and temperature, including vapour pressure/temperature relationship .2 types of electrostatic charge generation .3 chemical symbols Knowledge and understanding of tanker safety culture and safety management	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Communications within the area of responsibility are clear and effective Cargo operations are carried out in accordance with accepted principles and procedures to ensure safety of operations

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent hazards	Basic knowledge of the hazards associated with tanker operations, including: .1 health hazards .2 environmental hazards .3 reactivity hazards .4 corrosion hazards .5 explosion and flammability hazards .6 sources of ignition, including electrostatic hazards .7 toxicity hazards .8 vapour leaks and clouds Basic knowledge of hazard controls: .1 inerting, water padding, drying agents and monitoring techniques .2 anti-static measures .3 ventilation .4 segregation .5 cargo inhibition .6 importance of cargo Compatibility .7 atmospheric control .8 gas testing Understanding of information on a Material Safety Data Sheet (MSDS)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Correctly identifies, on an MSDS, relevant cargo-related hazards to the vessel and to personnel, and takes the appropriate actions in accordance with established procedures Identification and actions on becoming aware of a hazardous situation conform to established procedures in line with best practice

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Apply occupational health and safety precautions and measures	Function and proper use of gas-measuring instruments and similar equipment Proper use of safety equipment and protective devices, including: .1 breathing apparatus and tank-evacuating equipment .2 protective clothing and Equipment .3 resuscitators .4 rescue and escape Equipment Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to oil and chemical tankers, including: .1 precautions to be taken when entering enclosed spaces .2 precautions to be taken before and during repair and maintenance work .3 safety measures for hot and cold work .4 electrical safety .5 ship/shore safety Checklist Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Procedures for entry into enclosed spaces are observed. Procedures and safe working practices designed to safeguard personnel and the ship are observed at all times Appropriate safety and protective equipment is correctly used First aid do's and don'ts

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Carry out fire-fighting operations	Tanker fire response organization and action to be taken Fire hazards associated with cargo handling and transportation of hazardous and noxious liquids in bulk Fire-fighting agents used to extinguish oil and chemical fires Fixed fire-fighting foam system operations Portable fire-fighting foam Operations Fixed dry chemical system Operations Spill containment in relation to fire-fighting operations	Practical exercises and instruction conducted under approved and truly realistic training conditions (e.g., simulated shipboard conditions) and, whenever possible and practicable, in darkness	Initial actions and follow-up actions on becoming aware of fire on board conform with established practices and procedures Action taken on identifying muster signal is appropriate to the indicated emergency and complies with established procedures Clothing and equipment are appropriate to the nature of the fire-fighting operations The timing and sequence of individual actions are appropriate to the prevailing circumstances and conditions Extinguishment of fire is achieved using appropriate procedures, techniques and fire-fighting agents
Respond to emergencies	Basic knowledge of emergency procedures, including emergency shutdown	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training Programme	The type and impact of the emergency is promptly identified and the response actions conform to the emergency procedures and contingency plans

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent pollution of the environment from the release of oil or chemicals	Basic knowledge of the effects of oil and chemical pollution on human and marine life Basic knowledge of shipboard procedures to prevent pollution Basic knowledge of measures to be taken in the event of spillage, including the need to: .1 report relevant information to the responsible persons .2 assist in implementing shipboard spill-containment procedures	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Procedures designed to safeguard the environment are observed at all times

Table A-V/1-1-2 Specification of minimum standard of competence in advanced training for oil tanker cargo operations

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Ability to safely perform and monitor all cargo operations	*Design and characteristics of an oil tanker* Knowledge of oil tanker design, systems and equipment, including: .1 general arrangement and Construction .2 pumping arrangement and equipment .3 tank arrangement, pipeline system and tank venting arrangement .4 gauging systems and Alarms .5 cargo heating systems .6 tank cleaning, gas-freeing and inerting systems .7 ballast system .8 cargo area venting and Accommodation ventilation .9 slop arrangements .10 vapour recovery systems .11 cargo-related electrical and electronic control system .12 environmental protection equipment, including Oil Discharge Monitoring Equipment (ODME)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Communications are clear, understood and successful Cargo operations are carried out in a safe manner, taking into account oil tanker designs, systems and equipment Cargo operations are planned, risk is managed and carried out in accordance with accepted principles and procedures to ensure safety of operations and avoid pollution of the marine environment Potential non-compliance with cargo-operation-related procedures is promptly identified and rectified Proper loading, stowage and unloading of cargoes ensures that stability and stress conditions remain within safe limits at all times Actions taken and procedures followed are correctly applied and the appropriate shipboard cargo-related equipment is properly used Calibration and use of monitoring and gas-detection equipment comply with operational practices and procedures

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Ability to safely perform and monitor all cargo operations (*continued*)	.13 tank coating .14 tank temperature and pressure control systems .15 fire-fighting systems Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation Proficiency in tanker safety culture and implementation of safety-management system Knowledge and understanding of monitoring and safety systems, including the emergency shutdown *Loading, unloading, care and handling of cargo* Ability to perform cargo measurements and calculations Knowledge of the effect of bulk liquid cargoes on trim, stability and structural integrity Knowledge and understanding of oil cargo-related operations, including: .1 loading and unloading Plans .2 ballasting and Deballasting .3 tank cleaning operations .4 inerting .5 gas-freeing		Procedures for monitoring and safety systems ensure that all alarms are detected promptly and acted upon in accordance with established emergency procedures

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Ability to safely perform and monitor all cargo operations (*continued*)	.6 ship-to-ship transfers .7 load on top .8 crude oil washing Development and application of cargo-related operation plans, procedures and checklists Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment Ability to manage and supervise personnel with cargo-related responsibilities		Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe operational practices
Familiarity with physical and chemical properties of oil cargoes	Knowledge and understanding of the physical and chemical properties of oil cargoes Understanding the information contained in a Material Safety Data Sheet (MSDS)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Effective use is made of information resources for identification of properties and characteristics of oil cargoes and related gases, and their impact on safety, the environment and vessel operation

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent hazards	Knowledge and understanding of the hazards and control measures associated with oil tanker cargo operations, including: .1 toxicity .2 flammability and Explosion .3 health hazards .4 inert gas composition .5 electrostatic hazards Knowledge and understanding of dangers of non-compliance with relevant rules/regulations	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Relevant cargo-related hazards to the vessel and to personnel associated with oil tanker cargo operations are correctly identified, and proper control measures are taken
Apply occupational health and safety precautions	Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to oil tankers: .1 precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus .2 precautions to be taken before and during repair and maintenance work .3 precautions for hot and cold work .4 precautions for electrical Safety .5 use of appropriate Personal Protective Equipment (PPE)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Procedures designed to safeguard personnel and the ship are observed at all times Safe working practices are observed and appropriate safety and protective equipment is correctly used Working practices are in accordance with legislative requirements, codes of practice, permits to work and environmental concerns Correct use of breathing Apparatus Procedures for entry into enclosed spaces are observed

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Respond to emergencies	Knowledge and understanding of oil tanker emergency procedures, including: .1 ship emergency response Plans .2 cargo operations emergency shutdown .3 actions to be taken in the event of failure of systems or services essential to cargo .4 fire-fighting on oil Tankers .5 enclosed space rescue .6 use of a Material Safety Data Sheet (MSDS) Actions to be taken following collision, grounding, or spillage Knowledge of medical first aid procedures on board oil tankers	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	The type and impact of the emergency is promptly identified and the response actions conform with established emergency procedures and contingency plans The order of priority, and the levels and time-scales of making reports and informing personnel on board, are relevant to the nature of the emergency and reflect the urgency of the problem Evacuation, emergency shutdown and isolation procedures are appropriate to the nature of the emergency and are implemented promptly The identification of and actions taken in a medical emergency conform to current recognized first aid practice and international guidelines
Take precautions to prevent pollution of the environment	Understanding of procedures to prevent pollution of the atmosphere and the environment	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Operations are conducted in accordance with accepted principles and procedures to prevent pollution of the environment

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Monitor and control compliance with legislative requirements	Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL), as amended, and other relevant IMO instruments, industry guidelines and port regulations as commonly applied	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training Programme	The handling of cargoes complies with relevant IMO instruments and established industrial standards and codes of safe working practice

Table A-V/1-1-2 Specification of minimum standard of competence in advanced training for chemical tanker cargo operations

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Ability to safely perform and monitor all cargo operations	*Design and characteristics of a chemical tanker* Knowledge of chemical tanker designs, systems, and equipment, including: .1 general arrangement and Construction .2 pumping arrangement and equipment .3 tank construction and Arrangement .4 pipeline and drainage Systems .5 tank and cargo pipeline pressure and temperature control systems and alarms .6 gauging control systems and alarms .7 gas-detecting systems .8 cargo heating and cooling Systems .9 tank cleaning systems .10 cargo tank environmental control systems .11 ballast systems .12 cargo area venting and Accommodation ventilation .13 vapour return/recovery Systems .14 fire-fighting systems	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Communications are clear, understood and successful Cargo operations are carried out in a safe manner, taking into account chemical tanker designs, systems and equipment Cargo operations are planned, risk is managed and carried out in accordance with accepted principles and procedures to ensure safety of operations and avoid pollution of the marine environment

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Ability to safely perform and monitor all cargo operations (*continued*)	.15 tank, pipeline and fittings' material and coatings .16 slop management Knowledge of pump theory and characteristics, including types of cargo pumps and their safe operation Proficiency in tanker safety culture and implementation of safety management system Knowledge and understanding of monitoring and safety systems, including the emergency shutdown system *Loading, unloading, care and handling of cargo* Ability to perform cargo measurements and calculations Knowledge of the effect of bulk liquid cargoes on trim and stability and structural integrity Knowledge and understanding of chemical cargo-related operations, including: .1 loading and unloading Plans .2 ballasting and Deballasting .3 tank cleaning operations .4 tank atmosphere control		Procedures for monitoring and safety systems ensure that all alarms are detected promptly and acted upon in accordance with established procedures Proper loading, stowage and unloading of cargoes ensures that stability and stress conditions remain within safe limits at all times Potential non-compliance with cargo-related procedures is promptly identified and rectified Actions taken and procedures followed are correctly identified and appropriate shipboard cargo-related equipment is properly used

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Ability to safely perform and monitor all cargo operations (*continued*)	.5 inerting .6 gas-freeing .7 ship-to-ship transfers .8 inhibition and stabilization requirements .9 heating and cooling requirements and consequences to adjacent cargoes .10 cargo compatibility and Segregation .11 high-viscosity cargoes .12 cargo residue operations .13 operational tank entry Development and application of cargo-related operation plans, procedures and checklists Ability to calibrate and use monitoring and gas-detection systems, instruments and equipment Ability to manage and supervise personnel with cargo-related responsibilities		Calibration and use of monitoring and gas-detection equipment are consistent with safe operational practices and procedures Personnel are allocated duties and informed of procedures and standards of work to be followed, in a manner appropriate to the individuals concerned and in accordance with safe operational practices

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Familiarity with physical and chemical properties of chemical cargoes	Knowledge and understanding of the chemical and the physical properties of noxious liquid substances, including: .1 chemical cargoes categories (corrosive, toxic, flammable, explosive) .2 chemical groups and industrial usage .3 reactivity of cargoes Understanding the information contained in a Material Safety Data Sheet (MSDS)	Examination and assessment of evidence obtained from one or more of the following : .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Effective use is made of information resources for identification of properties and characteristics of noxious liquid substances and related gases, and their impact on safety, environmental protection and vessel operation
Take precautions to prevent hazards	Knowledge and understanding of the hazards and control measures associated with chemical tanker cargo operations, including: .1 flammability and Explosion .2 toxicity .3 health hazards .4 inert gas composition .5 electrostatic hazards .6 reactivity .7 corrosivity .8 low-boiling-point cargoes .9 high-density cargoes .10 solidifying cargoes .11 polymerizing cargoes	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Relevant cargo-related hazards to the vessel and to personnel associated with chemical tanker cargo operations are correctly identified, and proper control measures are taken

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent hazards *(continued)*	Knowledge and understanding of dangers of non-compliance with relevant rules/regulations		
Apply occupational health and safety precautions	Knowledge and understanding of safe working practices, including risk assessment and personal shipboard safety relevant to chemical tankers: .1 precautions to be taken when entering enclosed spaces, including correct use of different types of breathing apparatus .2 precautions to be taken before and during repair and maintenance work .3 precautions for hot and cold work .4 precautions for electrical Safety .5 use of appropriate Personal Protective Equipment (PPE)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service Experience .2 approved training ship Experience .3 approved simulator Training .4 approved training programme	Procedures designed to safeguard personnel and the ship are observed at all times Safe working practices are observed and appropriate safety and protective equipment is correctly used Working practices are in accordance with legislative requirements, codes of practice, permits to work and environmental concerns Correct use of breathing Apparatus Procedures for entry into enclosed spaces are observed

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Respond to emergencies	Knowledge and understanding of chemical tanker emergency procedures, including: .1 ship emergency response Plans .2 cargo operations emergency shutdown .3 actions to be taken in the event of failure of systems or services essential to cargo .4 fire fighting on chemical tankers .5 enclosed space rescue .6 cargo reactivity .7 jettisoning cargo .8 use of a Material Safety Data Sheet (MSDS) Actions to be taken following collision, grounding, or spillage Knowledge of medical first aid procedures on board chemical tankers, with reference to the Medical First Aid Guide for Use in Accidents involving Dangerous Goods (MFAG)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	The type and impact of the emergency is promptly identified and the response actions conform with established emergency procedures and contingency plans The order of priority, and the levels and time-scales of making reports and informing personnel on board, are relevant to the nature of the emergency and reflect the urgency of the problem Evacuation, emergency shutdown and isolation procedures are appropriate to the nature of the emergency and are implemented promptly The identification of and actions taken in a medical emergency conform to current recognized first aid practice and international guidelines

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent pollution of the environment	Understanding of procedures to prevent pollution of the atmosphere and the environment	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Operations are conducted in accordance with accepted principles and procedures to prevent pollution of the environment
Monitor and control compliance with legislative requirements	Knowledge and understanding of relevant provisions of the International Convention for the Prevention of Pollution from Ships (MARPOL) and other relevant IMO instruments, industry guidelines and port regulations as commonly applied Proficiency in the use of the IBC Code and related documents	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	The handling of cargoes complies with relevant IMO instruments and established industrial standards and codes of safe working practice